Module 6 - Steady State Circuits

ME3023 - Measurements in Mechanical Systems

Mechanical Engineering

Tennessee Technological University

Topic 3 - Circuit Applications

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- Circuits in Mechanical Engineering
- Drain Pipe Theory
- Example 1: LED Circuit
- Example 2: LDR circuit

Circuits in Mechanical Engineering

How much does a mechanical engineer need to know about electricity and magnetism? This is good question, and obviously it varies based on your particular area of mechanical engineering. However...

- System design is integrated! Look around you, can you find anything that was developed or designed without circuits? Engineering is an integrated discipline and very few products or designs are isolated so to a single field.
- Further, the need for measurements in mechanical systems drives the need for a mechanical engineer to have a solid foundation in basic circuits theory.

Circuits in Mechanical Engineering

Mechatronics

Many devices or designs combine mechanical and electrical systems. This is known as Mechatronics and if you are interested in this area you are in a great place to learn. TnTech Mechanical Engineering offers a concentration in Mechatronics Engineering. In this degree you will study both mechanical engineering and electrical engineering topic to give you the foundation to design truly integrated systems! Ask me or Dr. Canfield if you have any questions about this.

Drain Pipe Theory

Fluid Flow - Hydraulic Analogy

Traditionally engineers have used an analogy relating the movement of electrons to the flow of water through a pipe (hydraulic analogy) known as *drain-pipe theory*.

This may provide a sense of intuition *however* this comparison is not accurate do to the non-Newtonian nature of electricity and magnetism (more on this). It can be used to visualize some basic circuits principles, but it should not be used for analysis of complex electrical systems.

Example 1: LED Circuit

LEDs or Light Emitting Diodes are used more and more everyday and traditional *incandescent* lights are used rarely in new deigns. Why are LEDs better? Can you think of any trade-offs?

Pros:

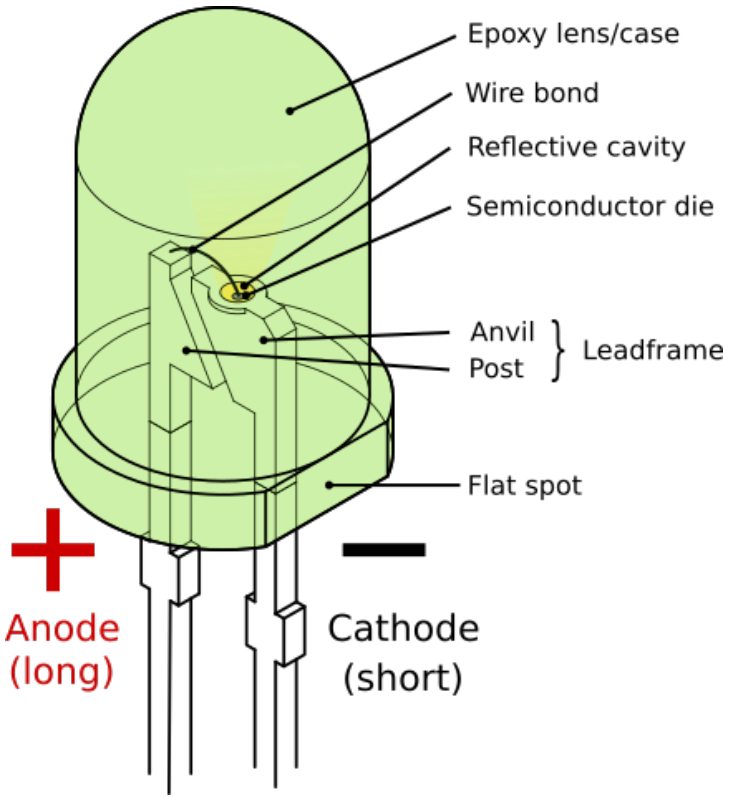
-
-
-

Cons:

-
-
-

Example 1: LED Circuit

An LED is designed to operate in a specific current range therefore is typically used in a voltage divider circuit that reduces the voltage across the LED so that the proper amount of current flows through the LED. Too little current not produce much light and too much current will destroy the LED or reduce the lifetime of the device.

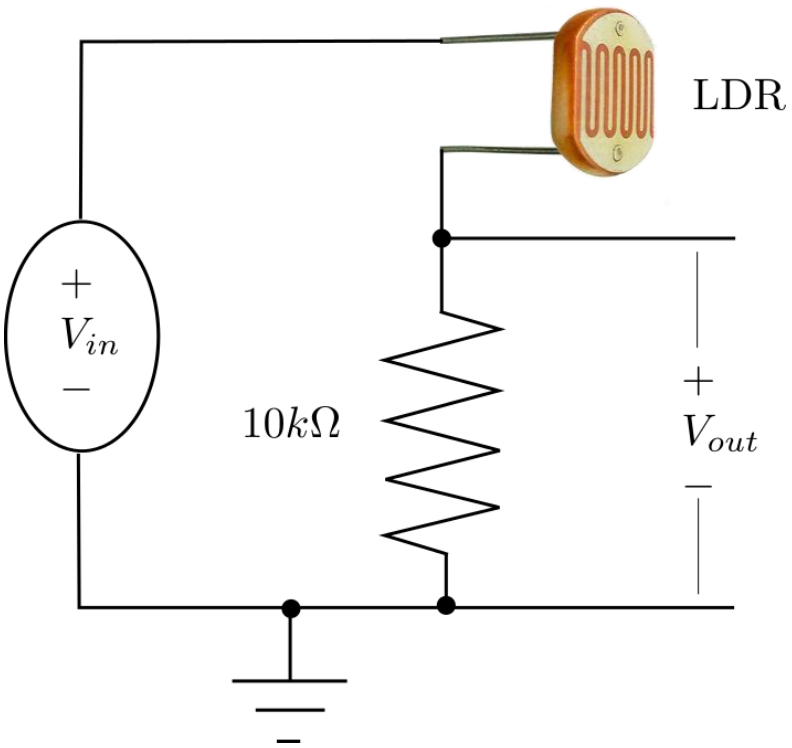


Example 1: LED Circuit

Design a circuit with an LED, a resistor, and a SPST switch for turning on the LED. Choose the resistor such that the current is in the appropriate for a typical LED ($\sim 20mA$). The voltage drop for a green LED at $\sim 20mA$ in known to be $\sim 3.5v$.

Example 2: LDR circuit

Consider this circuit for measuring light intensity with an LDR (light dependent resistor). The sensors is used in a voltage divider circuit.



1. Find the current in the circuit.
2. Find the voltage across the LDR and the $10K\Omega$ resistor.
3. Find the total energy dissipated in the circuit over 60 seconds.
4. Question: Why is the $10K\Omega$ resistor needed?

Example 2: LDR circuit